OCCUPANCY SENSORS

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INTRODUCTION

The new Lighting Design Guide contained in Engineering Instructions 16E001 discusses lighting controls using occupancy sensors. The intent of this paper is to provide the lighting designer additional information about the use and applicability of these devices and to provide a suggested guide specification to import into project specifications.

DESIGN PROCESS

It is highly recommended that the lighting designer consult with an application specialist of an authorized occupancy sensor manufacturer for assistance in the proper selection and location of occupancy sensors in the lighting design. The lighting engineer should provide the manufacturer's application specialist with all building floor plans necessary for accurate selection of sensor technology types and quantities per controlled room. In addition, the lighting designer should furnish the application specialist with the User's pertinent information on how each room is to be utilized, including whether open office areas will have systems furniture, individual offices will have wall-to-wall bookshelves, or whether the User plans to later install ceiling paddle fans. Occupancy sensor manufacturers offer this technical support service free of charge; some manufacturers include floppy disks with wiring diagrams in electronic (CAD) format. The following are among some of the manufacturers that provide occupancy sensors and free blueprint sensor layout service: The Watt Stopper (800) 879-8585; MyTech (888) 698-3248; and UNENCO (800) 227-0452. The lighting engineer must still show an accurate layout of occupancy sensors and associated system components on the drawings for bidding purposes and in order to include them in the project cost estimate.

TECHNOLOGIES

PASSIVE INFRARED (PIR)

PIR sensing systems are passive systems and react only to energy

sources (such as the human body) from within their control areas. They sense occupancy by "noticing" the difference in the heat emitted between the human body and the background. PIR sensors are best suited to monitoring open areas where there are no physical obstructions to block the sensor's field of view. PIR sensors must be able to "see" the area that needs to be monitored. Partitions and bookshelves will prevent detection in the blocked area.

ULTRASONIC

Ultrasonic sensors are volumetric motion detectors which utilize the Doppler Principle to detect occupancy. They broadcast sounds high above the range of human hearing to sense movement. Hearing aids operate in the range of 10 kHz to 20 kHz (source is Knowlls Elec. @ (630) 250-5100, a hearing aid microphone technology company). Filtering is provided on the microphone of hearing aids to prevent interference beyond 20 kHz, if needed. It is recommended for designers to specify ultrasonic sensors that operate at frequencies of minimum 32 kHz. Usually, ultrasonic sensors consist of several components: a transmitter, receivers and processing electronics. They work by bouncing ultrasonic sound waves off objects in the room and measuring the amount of time it takes for the waves to return. Movement in the controlled area causes the sound waves to return to the receiver at a faster or slower rate, resulting in a Doppler shift and occupancy detection. Ultrasonic sensors are suited to monitoring partitioned areas and areas with large objects, such as open office furniture, that are likely to block the field of view of PIR sensors.

DUAL TECHNOLOGY

Dual technology combines passive infrared and ultrasonic technologies into one unit. This technology provides occupancy sensor coverage to building spaces which have been too troublesome for single technology sensors. The combination of PIR and ultrasonic allows the sensor to take advantage of the best features of both technologies while eliminating the weaknesses. The result is sensors with greater sensitivity and coverage.

APPLICATIONS

Sensor Technology Best and Worst Applications:

PASSIVE INFRARED

Best Applications	Poor Applications
Enclosed offices	Restrooms
Warehouses	Areas where only very
Hallways, aisle ways	small motion is present
Areas with high air flow, rooms with ceiling paddle fans	
Areas requiring 100% coverage cut off	
Wall switch replacements	
Workstations	
High ceiling mount locations	
Library book stack aisles	

ULTRASONIC

Best Applications	Poor Applications
Open office spaces	Spaces w/ high air flow or vibration;
Conference rooms	Rooms with ceiling paddle fans;
Restrooms	High ceiling mounts above 14-16 feet;
Enclosed hallways	Small areas that are not enclosed;
Large areas up to 2000 sf.	Spaces w/ areas of unwanted detection

DUAL TECHNOLOGY

Best Applications	Poor Applications
Classrooms	NONE. (Dual technology will work in
Large conference rooms	almost every application; however,
Computer rooms	it is not cost-effective
Lunchrooms	
Open office spaces with defined aisles	
Areas with high ceilings	
Areas needing 100% cut off, small motion sensing	
Rooms with ceiling paddle fans	

CONTROL OF HVAC EQUIPMENT

To locally control HVAC equipment, occupancy sensors provide a dry contact for a digital input to air terminal units (ATUs) of variable air volume systems with DDC systems. In HVAC, occupancy sensors help stop unnecessary energy waste in unoccupied spaces by quickly reducing the "occupied minimum air flow setting" at designated ATUs which then reduce the central air handler’s fan speed and the chiller’s need to provide a high CFM of cold air. Air flow rate in CFM equates to energy, and energy to utility bills. Normal occupied mode room minimum air flow limits

typically range between 35% & 50% of the calculated maximum room CFM requirements. At present, the air flow is never allowed to drop below the minimum air flow limit (typically 35% to 50% of room max.), regardless of the room temperature or whether the room is occupied or momentarily unoccupied. With an occupancy sensor providing a dry contact digital input signal to the ATU controls, the minimum air flow limit would be determined based on the occupancy mode signal to the ATU controls as follows: the control system would use an occupied mode minimum air flow CFM limit of 35% to 50% of room max (as required) and an unoccupied mode minimum air flow CFM limit of 10% of room max (typical). The ATU maximum air flow CFM limit would not change based on occupancy. The occupied mode minimum air flow CFM limit for a room is determined by the mechanical system designer, and is normally shown on the mechanical drawings. The unoccupied mode minimum air flow CFM limit will ideally be as low as possible - for simplicity it can be a fixed percentage such as 10% of the room ATU maximum air flow limit. Only ATUs in 1 to 2 people office rooms and in small conference rooms will be interconnected to occupancy sensors at this time, providing that the VAV system is providing one ATU per room. If the ATU serves more than one office, then connect the occupancy sensors in parallel and then to the ATU. The total number of ATUs that should be interconnected to occupancy sensors, for a reduction of total average air flow CFM, must be limited by the requirement to maintain the central air handler's average minimum percent of total CFM above the point where the central air handler will tend to surge. Going under this average minimum percent of total CFM will make the air handler become unstable. Fortunately, this problem can be avoided simply by programming into the software of the DDC control system instructions such as the following: "DDC control shall not allow the average minimum air flow CFM, in percent of total CFM, to fall so low as to cause the central air handler to surge." This limit would be determined by the Contractor based on the central air handler procured for the facility, and the technical recommendations of the air handler manufacturer. The only hard wiring required is to provide the 24VAC control wiring between the occupancy sensor's additional internal isolated relay contacts and the ATUs box controller terminals; the Controls subcontractor will be required to provide this wiring under section 15951. The electrical engineer will inform the mechanical engineer that the lighting design will include occupancy sensors and in which offices and/or conference rooms the sensors will be interconnected to VAV air terminal units. The electrical engineer will specify on the electrical drawings which rooms will have occupancy sensors interconnected with ATUs and that 24VAC power wiring, in conduit, will be provided by the Contractor under section 15951 "DDC for HVAC."

Provide the mechanical engineer the ATU numbers that will be interconnected to occupancy sensors. Occupancy sensors to be connected to ATUs shall have an additional internal isolated relay with N.O., N.C., and Common outputs specifically designed for use with HVAC control, Data Logging and/or other similar control options. Occupancy sensors that require use of external components such as a power pack control unit, or that are specially modified, by someone other than the manufacturer, shall not be utilized for interconnecting with ATUs. For technical information on DDC controls for HVAC, one source is Landis & Staefa, Inc. (847)215-1000 or (916)553-4444. Two other sources are Honeywell (800)328-5111 and Johnson Controls (414)274-4000.

SUGGESTED SPECIFICATION

3.6.1 Occupancy Sensors

3.6.1.1 Work and Equipment Included

A. Contractor shall provide all labor, materials, tools, appliances, sensors, auxiliary control equipment, wiring, raceways, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein, and in the rooms indicated on the plans.

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If the electrical engineer proposes to interconnect occupancy sensors to ATUs, then include the following paragraph B. The electrical engineer shall inform the mechanical engineer in which small offices and/or conference rooms the sensors will be interconnected to VAV air terminal units. Specify on the electrical drawings which rooms will have occupancy sensors interconnected with ATUs and that 24VAC power wiring, in conduit, shall be provided by the Contractor under section 15951 "DDC for HVAC." Provide the mechanical engineer with the ATU numbers that will be interconnected to occupancy sensors and the special paragraphs, included as an ATTACHMENT at the end of this specification, that shall be added to specification 15951 for proper DDC coordination.
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[B. Provide under specification section 15951 "DDC for HVAC," the 24VAC power circuit wiring in conduit from the Air Terminal Units (ATUs) specified on the drawings notes to be interconnected to room occupancy sensors. These occupancy sensors shall be equipped by the manufacturer with an internal additional single pole. Double throw isolated relay with N.O., N.C., and common

outputs specifically designed for use with HVAC control, Data Logging and other similar control options.]

C. Contractor shall coordinate all work described in this section with Architectural, Mechanical, and Electrical plans and specifications, including but not limited to light fixtures, lighting wiring and conduit, HVAC systems and Direct Digital Controls, location of supply/return air registers/grills. Refer to architectural plans and cross-section elevations for ceiling heights and types of suspended ceilings and contours; for location of HVAC supply and return air registers/grills and light fixtures.

D. Occupancy sensors shall be coordinated with and be suitable for installation on a recessed junction box located in the suspended ceiling or on the wall at the edge of the suspended ceiling or in place of standard toggle wall switches. In large warehouses, occupancy sensors may be attached to tops of suspended light fixtures with approved accessories. Recessed junction boxes installed in fire-rated type suspended ceiling construction shall have the same fire proof rating as the ceiling panels, in conformance with UL-03.

3.6.1.2 Quality Assurance

A. All occupancy sensors and system component products supplied shall be from one manufacturer, and that has been continuously involved in the manufacturing of occupancy sensors for a minimum of three (3) years. They shall be rated for operation in ambient air temperatures ranging from 50 degrees F (10C) to 104 degrees F (40C) or in low temperature applications, ranging from -40 degrees F (-40C) to 95 degrees F (35C).

B. All occupancy sensors, power packs, and slave packs shall be U.L. listed, offer a five (5) year parts warranty and three (3) year labor warranty, and meet all state and local applicable code requirements, including applicable portions of the National Electrical Code.

C. Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The manufacturer’s equipment five (5) year warranty shall include paid postage, repair or replacement, and testing without charge to the owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the owner's acceptance of the project. Contractor’s

warranty on full labor cost shall be for a minimum period of one (1) year. Manufacturer's warranty on labor shall continue, after the contractor's first year, for an additional two (2) years with only a $10 labor allowance per item returned for troubleshooting.

3.6.1.3 Application Guidelines

Occupancy sensors shall not be connected to instant start fluorescent ballasts for instant start of lamps because they shorten the lamp life by at least 20 percent. Utilize only rapid start fluorescent ballasts in joint use with occupancy sensor lighting control. Designated constant-burn or emergency exit light fixtures, or emergency battery-and-lamp-supply-units for fluorescent or incandescent fixtures shall not be controlled by occupancy sensor power packs.

3.6.1.4 System Description

A. The occupancy sensor system shall be properly installed so that lighting is turned off automatically after a reasonable time delay when a room or area is vacated by the last person to occupy said room or area. The occupancy sensors shall utilize either the passive infrared (PIR) technology, ultrasonic motion technology, or dual technology PIR and ultrasonic sensors with load control driving circuitry and factory set timing to trigger ON. Factory set timing to hold the load ON shall be set at 15 minutes. When sensor(s) detect motion, they transmit a signal along a low voltage 24VDC circuit to power and slave pack control units, which then turn on lights (load) and/or interface with other systems (such as air terminal unit controls). If no motion subsequently occurs within a predetermined period of time, the lights are turned off. To insure continuous light while people are present or just stepping in and out of offices, the time delay range on each sensor shall be adjustable from a low of 15-30 seconds up to a high of 8-30 minutes to maintain lights ON. Sensors shall turn on the lights (load) within 2 feet of entrance into the room and shall not trigger ON from movement seen outside the room through doors or through windows. Likewise, after a room is vacated, sensors shall not maintain the load energized due to any movement originating outside the room or from any mechanical movement inside the room such as from ceiling paddle fans. Occupancy sensors shall be provided only in those rooms indicated on the project's lighting floor plan drawings.

B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits. Aisle or corridor occupancy sensors shall have a linear coverage pattern which allows an individual sensor

to detect half-step walking motion at any point within an unobstructed, enclosed 27.43 meters (90 feet) x 3.05 meters (10 feet x 3.05 meters (10 feet) ceiling, regardless of whether carpeting, wall fabric covering or irregularities in wall construction exist. Open office detector(s) shall detect small hand motions at any point within the entire area of application in the controlled room.

C. Occupancy sensors and power and slave pack control units shall be connected to power ahead of room light wall switches. Ceiling and corner mounting occupancy sensors shall operate at low voltage 24 VDC provided by power pack control units. Wall mounted occupancy sensor switches shall be dual voltage 120/277V for connecting directly to line voltage power circuits.

3.6.1.5 SUBMITTALS

A. Contractor shall substantiate compliance with this specification by submitting the necessary standard catalog literature of each occupancy sensor and power pack control unit components which includes performance specifications' data and wiring diagrams. Any deviations from this specification must be clearly stated by letter and submitted.

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To best design occupancy sensor location and control of lighting in open office areas with systems furniture and partitions, the lighting engineer should first become familiar with Interior Designer's placement of system furniture and partitions. Try to circuit groups of light fixtures that fall within clusters of systems furniture partitions in order to provide adequate symmetrical lighting that mirrors the occupants' use of the open office furniture layout.
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B. The contractor shall submit the architect's reflected ceiling floor plan(s) clearly marked by the manufacturer to show proper sensor technology selection, location and orientation of each sensor for one hundred (100) percent volumetric/range coverage to detect small hand motions in each controlled room, and to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The designer's contract drawings which show locations and quantities of sensors are diagrammatic and indicate only the rooms which are to be provided with sensors. Therefore, the manufacturer shall be responsible for requesting all of the project's electrical lighting floor plans, light fixture schedule and detail drawings, the architectural drawings and building cross sections to show

floors and room elevations, and interior design drawings which indicate the furniture package layout. Contractor shall provide a list of the controlled rooms with the following information, to indicate per room: 1) type of ceiling--suspended or open; 2) cross sectional shape of suspended ceiling--flat, bi-level ceiling, etc; 3) ceiling height; 4) light fixture type--incandescent, fluorescent, or other; 5) if placement of sensor is on recessed j-box, or attached to suspended light fixtures, as in warehouses; 6) manufacturer has coordinated placement of occupancy sensor on the suspended ceiling with locations of structural beams and HVAC supply/return air registers/grills shown on the architectural reflected ceiling plan; 7) manufacturer has coordinated with lighting designer to determine which rooms are pre-wired for future installation of ceiling paddle fans.

C. Contractor shall submit interconnection diagrams per room, showing quantities of occupancy sensors, technology and model types, power pack and slave pack control units, and groups of light fixtures controlled to including line voltage circuits and low voltage 24VDC circuit wiring diagrams. All circuiting shall be in conduit.

3.6.1.6 SYSTEM OPERATION

A. It shall be the contractor’s responsibility to count all lighting circuits throughout the building(s) which are occupancy sensor controlled and to verify each lighting circuit line voltage. The contractor shall be responsible for ordering all power pack and slave pack control units with the correct circuit line voltage.

B. The contractor shall provide a manufacturer’s factory authorized technician to make all proper adjustments, to train user's personnel, and to assure the user's satisfaction with the occupancy system.

C. The occupancy sensors and component system shall be installed in accordance with NFPA 70 (National Electrical Code) requirements and the manufacturer’s recommendations.

3.6.1.7 PERFORMANCE AND PRODUCTS: All occupancy sensors and control units shall be from ONE MANUFACTURER only.

A. The sensitivity and/or range of all sensors shall be from 0 - 100% and capable of detecting small desk oriented hand motion movements such as typing, writing, or turning pages of a report over the entire area of application within the controlled room.

All sensors shall utilize solid state electronic design.

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Wall switch sensors cannot be interlocked with HVAC air terminal units (ATUs) since wall sensors do not have an integral single pole, double throw isolated relay with N.O., N.C., and common outputs specifically dedicated for use with HVAC control. If DDC and a variable air volume type HVAC are provided and the lighting designer is proposing to interconnect some occupancy sensors with same room ATUs, then it is not recommended for designers to choose wall switch sensors in single or dual occupant offices or small conference rooms; but, instead provide ceiling sensors specifically designed to be interconnected with ATUs for added energy savings.
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B. Wall switch sensors shall be capable of detecting occupancy by small hand motion movements at desktop level up to 300 square feet, and gross motion up to 1000 square feet. Do not install sensors in locations where the necessary coverage range will be obstructed by doors or furniture.

C. Wall switch sensors shall be decorator style able to fit behind a standard decorator type wall plate. Sensors shall be a 3-wire completely self-contained control system designed to replace the standard toggle switch. Sensors shall have a ground wire for safety. Sensors shall be designed to fit in a standard single-gang switchbox. Mount in multi-gang box when adjacent to other switches. The switching mechanism shall be a latching air gap relay compatible with all fluorescent (including compact fluorescent) electronic ballasts with THD of less than 10%.

D. PIR wall switch sensors shall incorporate a vandal-resistant lens and choice of an auto-on/auto-off/manual-off switch. Wall switch sensors shall be unconditionally warrantied for the full 5 years term.

E. Wall switch sensors shall have no minimum load and shall be capable of switching loads from 0 to 600 watts or 1/6 HP at 120 volts, 60 Hz; 0 to 1200 watts or 1/3 HP at 277 volts, 60 Hz, and shall have 180 degree coverage capability. Sensors shall have no leakage current to the load, in manual or in Auto/Off mode, for safety purposes and shall have voltage drop protection.

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If the lighting designer is not proposing to interconnect the occupancy sensor system with local ATUs, then consider incorporating the following paragraph, if applicable.

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[F. Wall switch PIR sensors, in rooms with exterior facing windows, shall contain a built-in light level feature (adjustable from minimum 20 to 200 footcandles) which will hold lights OFF if a user-specified level of 30 FC (conference room), or 50 FC (offices) ambient natural light already exists. The user shall bypass this feature simply by placing hand over the sensor's face, for a second. The manufacturer's authorized factory technician shall verify room footcandle settings.]

G. Passive Infrared (PIR) sensors shall be immune to false triggering from RFI (walkie talkies) and EMI (electrical noise on the line), and shall exhibit superior performance and reliability. In addition, these sensors shall have a daylight filter which ensures that the sensor is insensitive to short-wavelength infrared waves such as those emitted by the sun. Ceiling mounted 360 degrees PIR sensors shall be capable of detecting occupancy at desktop level with small hand motion up to 500 square feet, and gross motion up to 1200 square feet. Additional sensors shall be provided, if necessary.

H. To insure detection with small hand motion at desktop level, PIR sensors shall have a dual level/segment, multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build up.

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Do not use single technology ultrasonic sensors in rooms with planned ceiling paddle fans.
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I. The ultrasonic sensor shall be capable of detecting presence in the floor area/room to be controlled by detecting Doppler shifts in transmitted ultrasound. Ultrasonic operating frequency shall be solid state crystal controlled 32 kHz, minimum, plus or minus 0.005% tolerance to assure reliable performance and eliminate sensor cross talk. Sensors throughout the building shall all be of the same frequency, to assure compatibility in the event more sensors are added or units are replaced.

J. Ultrasonic sensors shall have a multidirectional transmitter with temperature and humidity resistant, 32 kHz tuned ultrasonic receivers. Detection shall be maintained when a person of average size and weight moves only within or a maximum distance of 12 inches (30 cm) either in a horizontal or vertical manner at the approximate speed of 12 inches (30 cm) per second. Ceiling mounted 360 degrees ultrasonic sensors shall be capable of

detecting occupancy at desktop level with small hand motion only, from less than 500 square feet up to 2000 square feet, as applicable. If necessary, provide additional sensors.

K. Where specified, Passive Infrared and Dual Technology sensors shall be able to accommodate bi-level lighting control.

L. Dual Technology sensors shall incorporate PIR and ultrasonic technologies. Dual Technology sensors shall be corner mounted to avoid detection outside the controlled area when doors are left open. In the standard configuration, dual technology sensors turn lighting ON when both technologies sense occupancy. Then, detection by either technology will hold lighting ON. After the controlled area has been vacated for a set amount of time, lighting switches OFF. Other control options are available which need only one technology to trigger or both to hold the lighting ON.

M. Dual technology sensors consisting of PIR and Audio (micro phonics or sound) are not acceptable. They are prone to maintaining lights on indefinitely, due to their susceptibility to extraneous noises clearly heard inside the controlled room [such as from a phone ringing, PA, a radio left on, aircraft taking off, loud construction, etc.,] which are not made by the room occupants. In addition, this technology has only one manufacturer.

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These sensors utilize PIR to turn lights on and then use either the PIR or Audio technology to maintain lights on, until the room is vacated. However, there exists a strong possibility that any different sound occurring within the preset 15 minutes may continue to reset the 15 minute timer. Hence, light fixtures may be kept energized indefinitely, in an already empty room, if the timer is reset within the 15 minute interval due to a radio left on, a public address call, telephone ringing, fighter aircraft taking off, large trucks, passing traffic on a busy street, car honking, loud construction, or other loud noise that is different and quite audible inside of the controlled room. These dual technology sensors would not be recommended in rooms with ceiling paddle fans, if the motors become noisy.
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N. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner, heating fans, or ceiling paddle fans.

O. All sensors shall have readily accessible, user-adjustable controls for time delay and sensitivity. These controls shall be located on the sensor head, below the ceiling, and recessed to limit tampering.

P. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain ON constantly or control shall divert to a wall toggle light switch until sensor is replaced. This manual override control in the sensor shall be recessed to prevent tampering.

Q. All sensors shall provide a method of indication, such as a LED, to verify that motion is being detected during testing and that the unit is working.

R. Where specified to interconnect sensors to air terminal units of a variable air volume HVAC system, provide sensors that have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs specifically designed for use with HVAC control, Data Logging and other control options. Sensors utilizing separate and auxiliary external component(s) such as power pack control units or are specially modified units to achieve this function, shall not be acceptable.

S. All sensors shall have UL rated, 94V-0 flammability rated thermoplastic, rugged, high impact injection molded, and low-profile enclosures in white or off-white color. Size and weight of each sensor shall be as small and light as possible. Sensors, except those that require mounting on a swivel bracket, shall not be greater than 150 mm x 50 mm x 160 mm(6" H x 2.0" D x 6.25" W).

3.6.1.8 POWER AND SLAVE PACK CONTROL UNITS: Control units are intended for use in conjunction with ceiling-mounted occupancy sensors. Control units shall switch line voltage lighting loads and rated motor loads on and off in response to low voltage signals received from ceiling-mounted occupancy sensors. Control units shall have no minimum load requirements.

A. For ease of mounting, installation and future service, control units shall be able to externally mount through a knock out on a standard electrical junction-box enclosure with no exposed wiring, and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer. Control units shall rectify line voltage and provide 24VDC and 100mA (or 800mA, as required) low-voltage power to ceiling-mounted occupancy sensors. Each control unit shall provide power to, and receive control signals from, a minimum of two (2) sensors. Physical size of control units shall be

approximately 70 mm x 70 mm x 70 mm (2.75" x 2.75" x 2.75").

B. Control Unit integral relay dry contacts shall have U.L. listed ratings for switching:

1) 13A incandescent loads, 1 HP @ 120 or 277 VAC, 60 HZ
2) 20A @ 120 or 277 VAC, 60 HZ for all fluorescent lamp type electronic ballasts with THD of less than 10%
3) 20A @ 220-240 VAC, 50 HZ for all fluorescent lamp type electronic ballasts with THD of less than 10%
4) 13A incandescent loads, 1 HP @ 220-240 VAC, 50 HZ

C. Power packs shall be capable of parallel wiring without regard to AC phases on the primary, and be capable of working in a master/slave arrangement to control multiple circuits together.

D. Slave packs shall be identical in physical size of power packs and contain no transformer power supply, only an integral relay and dry contacts. They shall be capable of switching 120 VAC, 277 VAC, 220-240 VAC, 347 VAC @ 50 HZ or 60 HZ, or low voltage circuits.

E. Control wiring between sensors and controls units shall be size 18-24 AWG stranded THWN insulation, Class 2 according to NEC Section 725-52. Provide all control wiring only in EMT or flexible conduit, separated from 120V or 277V circuits.

3.6.1.9 INSTALLATION AND ADJUSTMENTS

A. It is the contractor’s responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the user's facility, to verify quantity, type, and placement of sensors, along with installation criteria.

B. It shall be the contractor’s responsibility to provide and place the manufacturer’s recommended quantity and type of sensors in each room.

C. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference by structural components.

D. All occupancy sensor systems shall be completely commissioned by the manufacturer’s factory authorized technician who will fine tune and verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting

control system, and to assure the user’s satisfaction. It shall be the manufacturer’s factory authorized technician’s responsibility to verify correct placement, location, and to aim sensor(s) in the correct direction which is required for a complete and proper volumetric/range coverage of each controlled room. This shall occur prior to building user move-in, but after installation of furniture systems, shelving, partitions, etc. Each controlled room shall have one hundred (100) percent volumetric/range coverage capable of detecting small hand motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room. The contractor shall provide additional sensors, if required by the manufacturer’s factory authorized representative, to properly and completely cover the respective room(s).

E. Manufacturer’s authorized factory representative shall verify that sensor time delay to hold the load ON is set to fifteen (15) minutes. Check LED indicator light of each sensor to verify that motion is being detected in the coverage range desired.

F. The contractor shall provide both the Contracting Officer and the User with ten working days written notice of the scheduled commissioning date.

G. Upon user acceptance of installed occupancy sensor system, sensor operating frequencies, ranges, and sensitivities shall not require further field adjustments to insure non-interference with other sensors in the controlled room. The manufacturer’s factory authorized technician shall provide the Contracting Officer three (3) binders, each with the following: 1) original catalog brochure copy with specification data and installation instructions for each sensor model and technology type installed; 2) per room name/number, provide the operating frequency setting, range setting, and sensitivity setting of each occupancy sensor installed for the entire building, in 8 ½ x 11 paper. Xerox copies of manufacturer’s literature, will not be accepted. The user shall be able to replace failed sensor units in the future and be assured of continued proper coordinated operation that matches initial installed conditions.

H. Prior to User move-in, but after commissioning of occupancy sensor system(s), the contractor shall provide a manufacturer's factory authorized technician at the user’s facility, to train user's personnel including up to two (2) Base [Post] electrician(s), a maximum total of 4 people for two 8 hour days, to familiarize them with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and

systems, and if required to replace sensors and power and slave pack control units, without voiding the manufacturer’s 5 year warranty.

I. The contractor shall provide minimum 10 spare of each power pack and slave pack control units, and 2 spare of each type of sensor installed, to the Contracting Officer who will turn them over to the user.

J. Multiple site visits by manufacturer’s factory authorized technician may be required depending on the project schedule and the success of the contractor in adhering to the manufacturer’s installation drawings and/or instructions. Contractor shall make available upon request of the manufacturer’s factory authorized technician, ladders and/or lift equipment and one electrical technician to assist in locating and gaining access to rooms where commissioning is to occur and to assist in any other way deemed necessary. Contractor shall incur the cost of a complete manufacturer’s factory commissioning for all sensors, power and slave pack control units, along with multiple site visits if necessary, as a part of this contract.

ATTACHMENT

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If occupancy sensors will be interconnected to the VAV air terminal units, provide the mechanical engineer with the following modifications to specification 15951 to coordinate the DDC programming to protect the central air handler, to properly assign the work to wire the ATUs, and how the Contractor shall accomplish this work.
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Add to Specification 15951, "Direct Digital Control for HVAC"

Add to 2.13.2 Variable Air Volume (VAV) Terminal Unit Controls

[A certain number of VAV air terminal units shall also be interconnected to the room occupancy sensors as specified in Section 16415, paragraph "Occupancy Sensors." Furnish control wiring and conduit from the individual air terminal unit (ATU) box controller to the appropriate room occupancy sensor, and terminate on the occupancy sensor’s internal additional isolated relay dry contacts, as required. ATUs controlled by occupancy sensors are shown on the mechanical and electrical project

drawings.]

Add to 3.3.3.11 Pressure-Independent Terminal VAV Box with Velocity Controller

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The mechanical designer shall check with the electrical engineer on whether single or dual occupant office rooms and small conference rooms will have VAV air terminal unit box controllers interconnected to room lighting occupancy sensors. The mechanical designer shall then determine if the combined number of ATU box controllers, interconnected to occupancy sensors and programmed to reduce minimum air flow limit to 10% on an unoccupied input signal from a room occupancy sensor, could reduce the average minimum air flow demand, in percent of total CFM, so low to where the central air handler may tend to surge and potentially become unstable, while using a variable frequency drive. If this can possibly be the case, include the following second sentence in brackets. Adding DDC programming to prevent an air handler from being driven near its surge point is expensive and is not necessary on all VAV designs. Therefore, the mechanical designer should not needlessly include this additional programming when only a few ATUs will be interconnected to occupancy sensors.
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[For VAV air terminal unit box controllers with Occupancy Sensor inputs, the controller's minimum air flow limit will have occupied and unoccupied settings which will be selected based on an input signal from the Occupancy Sensor. The box controller's occupied mode minimum air flow CFM limit will be 35% to 50% of room maximum, unless indicated otherwise on the mechanical drawings. The controller's unoccupied mode minimum air flow CFM limit will be a fixed percentage of 10% of room maximum, typical.] [Direct digital control shall be programmed to not allow the sum total number of ATU box controllers that throttled back to 10% to reduce the average minimum air flow, in percent of total air handler CFM, to fall so low as to cause the central air handler to surge and become unstable. The Contractor shall obtain from the manufacturer of the central air handler, the fan safety limit where the air handler will surge and shall program the DDC to override occupancy sensor inputs to ATU box controllers and maintain minimum air flows of 35% to 50%.]